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ABSTRACT

This study examined the relation of reading ability, age, and familiarity to iconic and short-term memory processing and how the familiarity of the stimuli affects recall. A total of 10 children in grades 2 through 6 and 10 adults were shown novel abstract forms, words, and non-words varying in order of approximation to English, for 50 msec., 500 msec., and 1,000 msec. Subjects were asked to recall either a row of items or as many of the items as possible. The number of recall errors reported by adults and children of varying reading abilities were compared. The results revealed that reading ability and age had significant effect on memory processing when words and non-words were displayed. With non-words, differences were greater for letter sequences that closely resembled English. No differences in recall were found between reading abilities and age groups when abstract forms were displayed. The results suggest that items in memory are primarily being coded phonologically rather than visually. (MDM)

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The Relation of Age and Reading Ability to Memory Processing

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Suggested running head: Reading ability and memory

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Abstract

This study examines the relation of reading ability, age, and familiarity to iconic and short-term memory processing using a partial and full report backward masking paradigm. Children and adults were shown novel abstract forms, words, and non-words varying in order of approximation to English, for 50 msec., 500 msec., and 1000 msec. and asked to recall either a row of items or as many of the items as possible. The number of errors in recall reported by adults and children of varying reading abilities were compared. The results revealed that reading ability and age had a significant effect on memory processing when non-words and words were displayed. With non-words, differences were greater for letter sequences that closely resembled English. No differences in recall were found between reading abilities and age groups when abstract forms were displayed. The results suggest that items in memory are primarily being coded phonologically rather than visually.

The Relation of Age and Reading Ability to Memory Processing

This research examines the effects of age and reading ability on iconic and short-term memory processing. The issue of how memory functions in poor readers has been extensively researched, particularly regarding the issue of short-term memory processing (Brady, 1991). While some research has also been done on iconic memory, the results have been inconclusive (Vellutino, 1979). Few investigators have looked at how the initial stages of processing interacts with other variables contributing to reading difficulties such as familiarity and orthographic knowledge.

The purpose of the present study was to examine whether reading ability and age are related to iconic and short-term memory processing and how the familiarity of the stimuli effects recall. Empirical research (Brady, 1991) has demonstrated that poor readers display visual memory deficits for verbal material but not for non-verbal material (i.e. lacking a verbal label) when compared to good readers. Further, it has been demonstrated that poor readers have difficulty with a variety of phonological tasks such as naming items in a sequence and breaking up words into sound (Fox & Routh, 1980). Thus, researchers have speculated that poor readers' memory deficits have more to do with a specific phonological deficit than with general memory problems. If correct, this would suggest that poor readers would

perform similarly to good readers when non-verbal material is displayed on iconic as well as short-term memory tasks. By increasing the familiarity of the stimuli presented (i.e. varying the stimulus to more closely approximate the English language), it is possible to examine if familiarity of letter patterns and letter sounds effects recall.

The first hypothesis was that reading ability would be related to recall when verbal material was displayed but would not relate to recall when abstract forms were displayed. The second hypothesis was that recall would improve as the stimuli more closely resembled English. The final hypothesis was that iconic and short-term memory for all of the stimuli would improve with age.

Method

Subjects

Ten adult subjects (X=19.5) were recruited from an introductory psychology class at Texas Tech University and were given class credit for participating in the study. Two groups of children were randomly recruited from a public elementary school in an urban school district. The first group of children included five second and third graders (X=7.8), and the second group of children included five fifth and sixth graders (X=11.2). All subjects spoke English as their first language.

Materials

The stimuli were presented to subjects on a 386sx IBM

compatible computer with a 14 inch diagonal, high resolution, non-glare VGA color monitor. The visual stimuli consisted of a four by four matrix of either words, non-words (based on first and fourth order approximations to English non-repeated letter sequences by Hirata & Bryden, 1971), or standard computer generated abstract forms. The abstract forms were twenty-four novel and difficult to verbally label symbols. In the cue condition, one bar appeared on each side of the row that was to be reported. Fifty msec. following the stimulus presentation, the cue appeared for 50 msec.. A four by four dot matrix appeared 50 msec. following stimulus presentation and remained for 500 msec. while the cue was presented. Either a letter or abstract form cardboard response grid that contained the possible responses arranged in random order was placed next to the computer.

Procedure

Subjects were individually tested by one of three examiners (1 male, 2 female). Initially, all subjects were administered the vocabulary and block design subtests of the WAIS-R or WISC-III to ensure the subjects were of average intelligence or above. To estimate reading ability, subjects were administered the reading subtest of the WRAT-R. The subject's name, date of birth, grade, race, and gender were recorded.

Subjects were then asked to sit on a chair placed in front of a standard IBM computer. The viewing distance was

approximately 14 inches. The standard partial and full report procedures for examining iconic memory (Sperling, 1960) were used. The subjects were given 15 practice trials to become familiar with the procedures. If subjects did not understand the procedures, they were given more practice trials. For the testing sessions, each within subject condition consisted of 10 display trials. Before each set of trials, subjects were told whether they would be required to report the full array or the row of items that the indicator pointed to. The subjects were instructed to say "ready" when they wished to initiate the presentation of the stimuli and to focus on the fixation dots in the center of the screen. After a 500 msec. delay, the stimulus array appeared for either 50, 500, or 1000 msec.. In the cue condition, the stimuli were followed by a cue presented for 50 msec., appearing 50 msec. after the stimuli. A mask was displayed for 500 msec.. The mask appeared 50 msec. after the presentation of the stimuli. In the cue condition, the mask and the cue were displayed simultaneously. The order of conditions was counterbalanced.

Within a sequence of trials, subjects set their own rate of responding. Subjects were instructed to report either a row of items or all of the items by pointing to correct items on the response grid or saying the items aloud. Subjects were encouraged to give an educated guess when they were not sure. The experimenter entered the responses in the computer. Subjects

had approximately five 30 minute testing sessions and were given encouragement and positive feedback throughout.

Results

The dependent measure of recall was the number of incorrect items. An item was considered incorrect if a letter was not identified in its correct position. For the cue condition, incorrect responses were multiplied by four (Sperling, 1960), in order to compare the cue to the non-cue condition.

In order to evaluate the effect of stimulus type, reading ability, and grade on recall, a mixed factorial ANCOVA was conducted using reading ability as a covariate, grade (2nd to 3rd grades, 5th to 6th grades, and undergraduates) as the between subjects variable, and stimulus type (4 visual stimuli) as the within subject variable. The effect of reading ability on the overall number of errors in recall was significant, $F(1,15)=14.06$, $p<01$. Grade also had a significant effect on errors in recall, $F(2,15)=25.45$, $p<.001$ (see Figure 1). The results indicate that as grade and reading ability increased, the number of errors in recall decreased. Reading ability was a standard score and therefore not confounded by age. Reading accounted for 52 percent of the variance in overall recall. The effect of stimulus type was also found to be significant, $F(3,48)=196.40$, $p<.001$. Subjects performed no differently from one another when abstract forms were displayed. In contrast, errors in recall decreased when first order approximations to

English were displayed (i.e. most unlike English). Errors decreased further when fourth order approximations to English (i.e. similar to English) and words were displayed (see Figure 2). Regression analysis revealed that when first order approximations to English were displayed, reading ability accounted for 31 percent of the variance in recall, $F(1,16)=7.17$, $p=.017$. When fourth order approximations to English were displayed, reading ability accounted for 37 percent of the variance in recall, $F(16,1)=9.43$, $p<.01$. When words were displayed, reading ability accounted for 49 percent of the variance of recall, $F(1,16)=15.38$, p,.001.

Insert Figures 1 and 2 about here

To examine the effect of stimulus duration, a one-way ANOVA was conducted using duration as the within subjects variable. The effect of duration was significant, $F(2,32)=23.57$, $p<.001$, indicating that with longer stimulus durations, subjects made fewer errors in recall.

While follow up planned comparisons were not performed on these findings, an examination of the means reveals that differences were in the expected direction. It was expected that errors in recall would decrease with grade. Interestingly, while there were differences between grades when letters were displayed, there were no differences when abstract forms were

displayed. The mean number of errors in recall when letters were displayed for grades two through three, five through six, and college undergraduates was 121, 102, and 91 respectively.

As hypothesized the number of errors also decreased with stimulus familiarity. The mean number of errors when abstract forms were displayed was 151. When first order approximations to English were displayed, the mean number of errors was 124. When fourth order approximations to English were displayed, the mean number of errors was 113, and when words were displayed the mean number of errors was 89.

Lastly, it was expected that subjects would make fewer errors in recall when the stimuli were displayed for longer duration periods. The mean number of errors in recall when the stimuli were displayed for 50, 500, and 1000 msec.s were 121, 99, and 86 respectively.

Discussion

Reading ability was found to be related to recall when letters were displayed but not when abstract forms were displayed. This suggests that reading ability is not associated with general memory problems but rather has to do with difficulty processing phonological material.

As the stimuli increasingly resembled English, errors in recall decreased for all subjects. This suggests that subjects were able to recall more items wher the letters could be read as a single unit than when the items could not be read as a unit.

While all subjects demonstrated fewer errors in recall with increased familiarity, the number of errors decreased as reading ability increased. This suggests that reading ability is related to the ability to recognize and store letter patterns and sounds. During reading, iconic images of words must be retained long enough for their features to be transferred into short-term memory for meaning analysis (Just & Carpenter, 1987). Thus, memory for verbal material and familiarity with phonological material is crucial to reading and would be expected to be related to reading ability.

Developmental increases in memory for verbal material was supported. However, adults performed no better than children when abstract forms were displayed. This suggests that developmental increases in memory are directly related to familiarity with the items to be remembered and with phonological processing.

The decrease in recall errors with increased duration suggests that with more processing time, more information is able to be remembered. This finding was more pronounced as familiarity increased. Thus, it seems that when the information presented resembles English, subjects were able to make better use of the exposure time. That is, with increased familiarity, comes greater efficiency in storage and recognition.

While these findings are suggestive of the use of phonological coding strategies in memory, further analysis is

planned to determine the specific roles of phonological and visual coding. In addition, an examination of cognitive scanning strategies will help to determine whether poor readers are less systematic than good readers. Finally, a sample of subjects with reading disability are being collected for comparison with poor and good readers.

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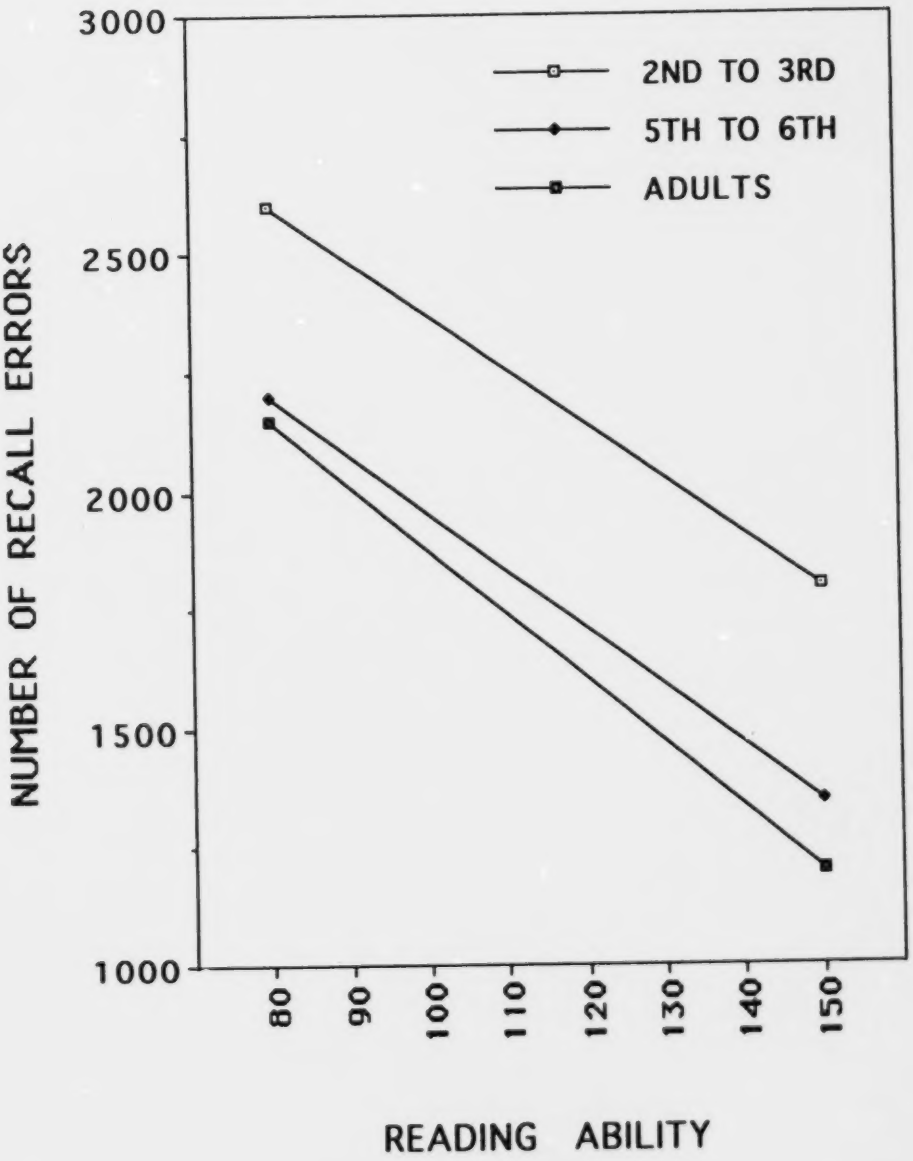
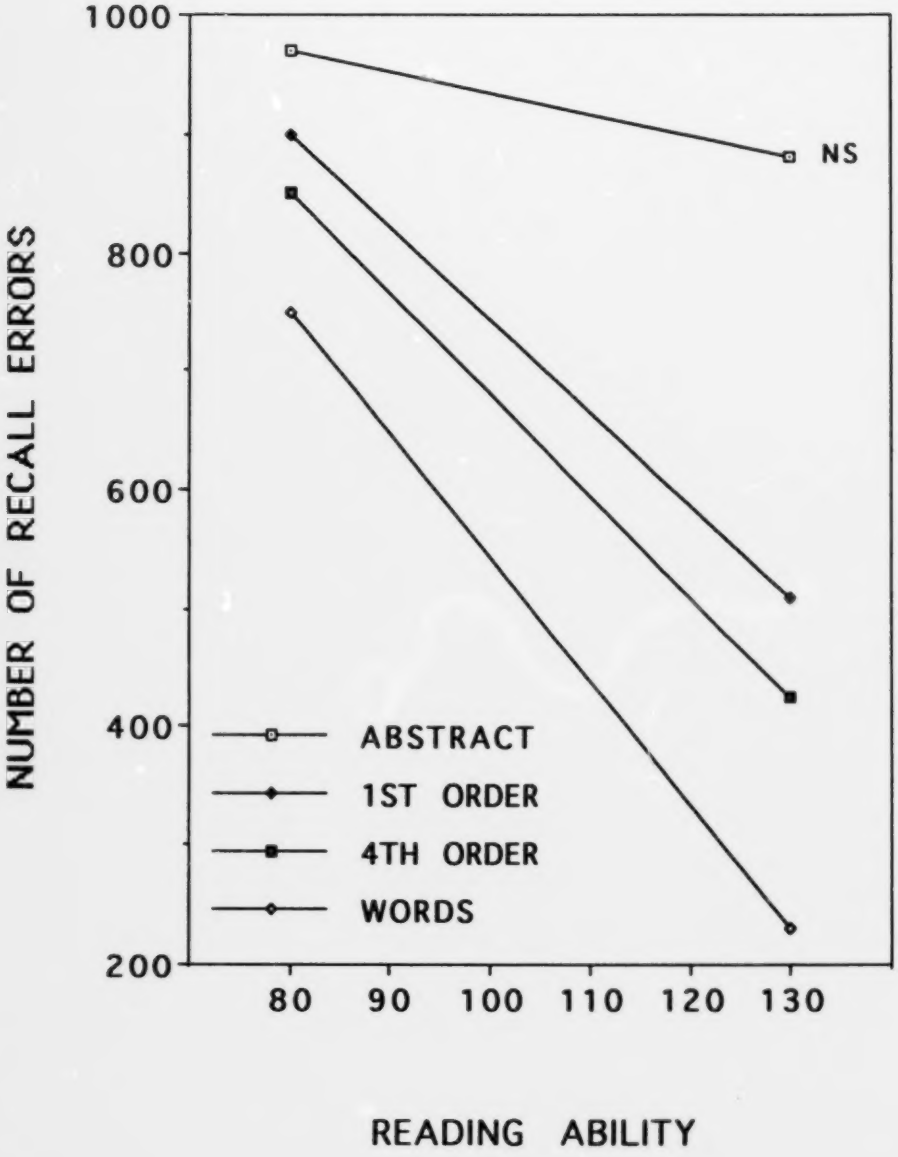
Figure Caption

Figure 1. The number of recall errors as a function of grade and reading ability.

Figure 2. The number of recall errors as a function of reading ability and familiarity.


3000
2500
2000
1500
1000
NUMBER OF RECALL ERRORS
2ND TO 3RD
5TH TO 6TH
ADULTS
80
90
100
110
120
130
140
150
READING ABILITY


1000
800
600
400
200
NUMBER OF RECALL ERRORS
NS
ABSTRACT
1ST ORDER
4TH ORDER
WORDS
80
90
100
110
120
130
READING ABILITY